SETOGENESIS AND GROWTH OF THE FRESHWATER PRAWN *PALAEMONETES ARGENTINUS* (DECAPODA, CARIDEA, PALAEMONIDAE)

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ABSTRACT

The moulting cycle and the relationship between moulting and growth of *Palaemonetes argentinus* Nobili, 1901 in laboratory reared animals are presented. Juveniles (from 0.03 g to 0.34 g) were collected from Punta Mogotes ponds in Mar del Plata, Argentina, and maintained in isolation using freshwater, natural light (L:D 11h13min), temperature 20±2°C, and fed with a pelletized diet. Moulting stages were described on the development of the uropod setae and stages A, B, C and D, and premoult substages (D_0, D_1', D_1'', D_1''' and D_2) were identified. The process of setogenesis is similar to those described for other decapod species. In *P. argentinus* premoult period was the longest (60%) of the cycle. The moult increment was studied comparing pre and postmoult wet weights; a growth coefficient of b = 1.03 (r = 0.99) was found, showing an arithmetic growth. The average duration of the intermoult period was 25±4 days; this value is dependent of the premoult weight (r = 0.57). The percentage weight increment decreases with age according to a linear correlation (r = 0.65).

KEYWORDS. Decapoda, *Palaemonetes argentinus,* Setogenesis, Growth.

INTRODUCTION

Periodic moulting of the hard exoskeleton is a growth-related phenomenon common to all crustacean. As a consequence of the discontinuous nature of growth it can be broken down into two components: the moult increment and intermoult period. These two elements of the growth process are essentially discrete, often exhibiting very different responses to intrinsic and extrinsic changes; thus, a proper understanding of growth demands that they be analyzed separately, before they are combined to present growth as a straightforward increase with time (HARTNOLL, 1982).

Palaemonetes argentinus Nobili, 1901 is a widely distributed prawn in the Argentine central littoral region. It plays an important trophic role in most of lagoons and artificial ponds, being part of the diet of several freshwater fishes species. Studies on the ovarian

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maturation cycle (GOLDSTEIN & LAURÍA-DE-CIDRE, 1974; SCHULDT, 1980), larval development (MENU-MARQUE, 1973) and population dynamics of *P. argentinus*, (DONATTI, 1986; RODRÍGUEZ-CAPÍTULO & FREYRE, 1989) have been carried out. Informations on the moulting cycle and its relationship with growth in *Palaemonetes varians* (Leach, 1814) (JEFFERIES, 1964) and *P. pugio* Holthuis, 1949 (FREEMAN & BARTELL, 1975), *Macrobrachium borellii* (Nobili, 1896) (BOND & BUCKUP, 1988) and species of other caridean genus such as *Palaemon* Weber, 1795, are available, but these aspects have not yet been studied in *Palaemonetes argentinus.*

The aim of this work was to study the moulting cycle of *P. argentinus* through the examination of the uropods setogenesis and to determine the moult frequency and weight increment at moult under laboratory conditions.

MATERIAL AND METHODS

Juveniles (range 0.030 to 0.338 g) were collected from Punta Mogotes ponds in Mar del Plata, Argentina (38°S) with a hand net. They were kept individually in glass containers (300ml) with freshwater at 20±2°C, under a photoperiod of 11h light: 13h dark. The water was changed every five days, and was gently aerated at all times. The containers were checked once a day for moulting, and the exuvia removed. During the trial they were fed daily with a pelletized diet with 56.2% protein, 6.9% lipids, 8.5% moisture, and 11.3% ashes. Prior to feeding uneaten food was siphoned off.

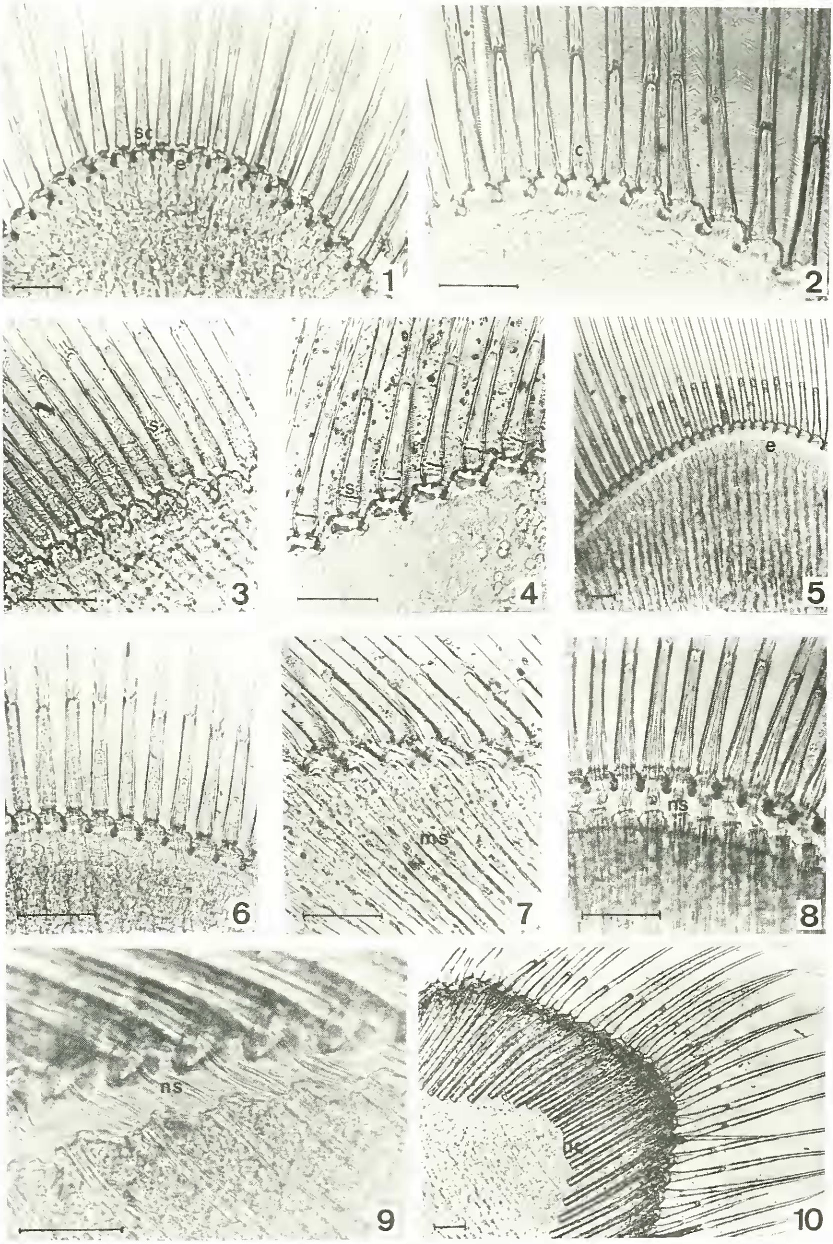
For the description of setogenesis, the uropods apex from 18 individuals were cut and examined at intervals of two days after the ecdysis. The description of moult stages was done according to DRACH & TCHERNIGOVTZEFF (1967). Other group of 20 individuals was used to determine the length of each stage of the cycle.

Twenty eight individuals were used to determine moult increment and moult frequency. Ovigerous females were not used in this study. The first moult cycle in captivity was not considered because this is often aberrant. Moult increment was studied comparing pre and postmoult wet weights and its adjustment to different regression models (KURATA, 1962). The regressions were considered significant at $p<0.001$ (SOKAL & ROHLF, 1979). For this purpose, individuals were isolated and maintained under conditions formerly described. Wet weight increment was recorded by weighting the individuals two days after the ecdysis. The balance used was sensitive to 0.1mg. The examined material was stored in Science Marine Department, Mar del Plata University.

RESULTS

I. Moulting cycle. Four major stages (A, B, C and D) and five premoult substages (D_0, D_1', D_1'', D_1''' and D_2) were identified (figs. 1, 10). The duration of moult stages was: postmoult 2-3 days, intermoult 4-6 days, premoult 13-16 days. Setogenesis was similar to that described for other Caridea:

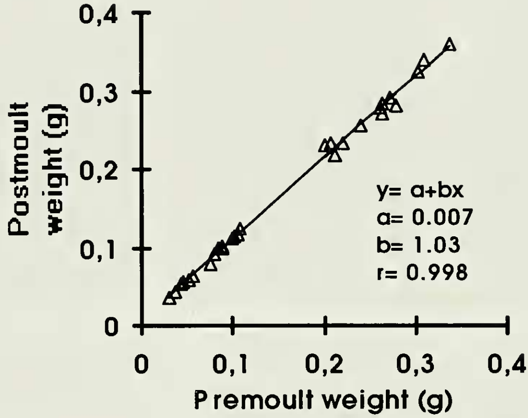
Stage A: (early postmoult) the setal content (sc) is homogeneus and vacuolated. There is no retraction of the setal matrix and the epidermis (e) reaches the base of setal articulation (fig. 1). **Stage B:** (late postmoult) setal matrix retraction begins, with the development of cones (c) in some of the setae (fig. 2). **Stage C:** (intermoult) cones are completely developed in all of the setae and setal matrix retraction continues towards setal articulation. Parallel to setal articulation a septus (s) can be observed. Epidermis starts moving away from the base of the setae (figs. 3, 4). **Stage D:** (premoult) the formation of the new setae takes place. The following substages could be recognized: Substage D_0: (early premoult) the epidermis (e) shows a maximum retraction (apolysis) from the cuticle (fig. 5). Substage D_1': the invagination of the epidermis takes place and epidermal line becomes wavy (fig. 6). Substage D_1'': new setae matrix (ms) is forming inside parallel



Figs. 1-10. Uropods of *Palaemonetes argentinus*: 1, stage A; 2, stage B; 3, 4, stage C; 5, substage D_0; 6, substage D_1'; 7, substage D_1''; 8, 9, substage D_1'''; 10, substage D_2 (c, cones; e, epidermis; ms, new setae matrix; nc, new cuticle; ns, new setae; s, septus; sc, setal content). Scale bars = 50µm.

double-wall channels in the uropod matrix (fig. 7). Substage D_1''': the new setae are completely formed (fig. 8). Barbules are noted in some setal shafts. The evagination of the new setae (ns) starts reaching the basis of the old ones (fig. 9). Substage D_2: the premoulting layers of the new cuticle (nc) are clearly visible (fig. 10).

II. Growth. There were not differences between sexes. A linear correlation (r = 0.99) was determined between pre and postmoult weights (tab. I) and the value of the growth coefficient was b = 1.03 (fig. 11).



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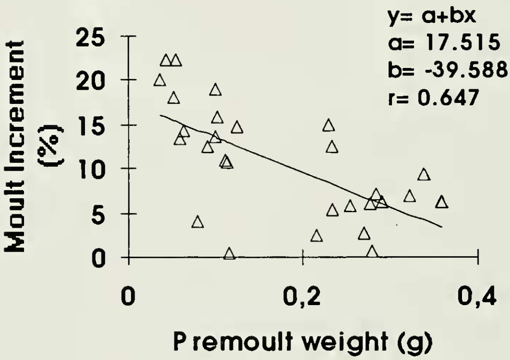

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Figs. 11, 12. *Palaemonetes argentinus*: 11, Relationship between premoult weight and postmoult weight; 12, Relationship between percentage weight increment and premoult weight.

Table 1. Growth of *Palaemonetes argentinus* under laboratory conditions. (IW, FW, pre and postmoult weight; %WI, percentage weight increment; D, intermoult period)

Specimen number	IW (g)	FW (g)	%WI	D (days)	Specimen number	IW (g)	FW) (g)	%WI	D (days)
1	0.030	0.036	20.00	18	15	0.108	0.124	14.81	22
2	0.036	0.044	22.22	26	16	0.200	0.230	15.00	32
3	0.044	0.052	18.18	20	17	0.208	0.234	12.50	26
4	0.045	0.055	22.22	18	18	0.212	0.217	2.35	23
5	0.052	0.059	13.46	15	19	0.221	0.233	5.43	25
6	0.056	0.064	14.28	22	20	0.241	0.255	5.80	27
7	0.076	0.079	3.94	22	21	0.262	0.278	6.10	29
8	0.080	0.090	12.50	19	22	0.264	0.271	2,65	31
9	0.084	0.100	19.04	30	23	0.264	0.283	7.19	26
10	0.088	0.100	13.63	26	24	0.273	0.290	6.22	29
11	0.088	0.102	15.90	22	25	0.278	0.280	0.71	27
12	0.100	0.111	11.00	30	26	0.302	0.323	6.95	26
13	0.102	0.113	10.78	28	27	0.309	0.338	9.38	28
14	0.106	0.116	0.43	30	28	0.338	0.359	6.21	29

The percentage increment varied between 0.43 and 22.22. Compared to the premoult weight it showed a linear correlation ($r = 0.65$) (fig. 12).

The average length of the intermoult period was 25±4.4 days and the correlation between premoult weight and moult frequency gave $r = 0.57$ for weights ranged fom 0.03 to 0.34 g. All regressions were significant ($p<0.001$).

DISCUSSION

The length of the intermoult period of *P. argentinus* was 25±4.4 days, which was coincident with that found for this species by Setz & Buckup (1977). In the prawn *P. argentinus*, like most of Caridea, premoult was found to be the longest, representing 60% of the cycle.

Postmoult stages could be distinguished by the absence (stage A) and the presence of cones in development in some of the setae (stage B). In the intermoult, cones were completely formed in all of the setae. These setal changes were coincident with those described for other carideans as *Macrobrachium rosembergii* (De Man, 1879) (Peebles, 1977) and some species of penaeids as *Artemesia longinaris* Bate, 1888 (Petriella, 1984) and *Penaeus esculentus* (Haswell, 1879) (Smith & Dall, 1985). In contrast, Shyama (1987) never mentioned the development of cones for *Macrobrachium idella* (Hilgendorf, 1898). In *P. argentinus* the presence of a septus in the cones in all of the setae in C stage, probably resulting of the setal matrix retraction, was a distinctive morphological feature.

The premoult stage in *P. argentinus* was similar to those reported for some other species of decapods. The D_0 stage can be defined as the substage at which apolysis (JENKIN & HINTON, 1966) is total and maximum, although the epidermal retraction begins towards the end of the intermoult, as noted by other authors (SCHEER, 1960; PETRIELLA, 1984; SMITH & DALL, 1985; DÍAZ & PETRIELLA, 1990). During substage D_1 the development of new setae occurs. In D_1' the epidermal line develops folds; in D_1'' these folds deepen forming double-wall channels and in D_1''' the new setae are completely developed and their evagination takes place. In the substage D_2 the secretion of the preexuvial layers begins (PASSANO, 1960) and these are seen as a pigmented line parallel to the epidermis bording the new setae. In certain species of Caridea can be recognised the premoult substages D_3 and D_4, however, in *P. argentinus* it is not possible to distinguish them.

The moulting cycle is closely correlated with other important factors including growth, reproduction, natural mortality, migration and recruitment (CADDY, 1987). The ecdysis frequency of crustaceans in nature is a more difficult variable to measure and may have to be deduced indirectly, for instance from tagging and release experiments (PENN, 1975; MONTGOMERY **et al.**, 1995) or through laboratory experiments (MENZ & BLAKE, 1980; PETRIELLA, 1986; DÍAZ & PETRIELLA, 1988). The first method is only practicable for species where commercial catches ensure an adequate return of marked individuals and the latter presents two problems: (1) the length of the moulting period will vary with ambient conditions and (2) many methods of sampling select strongly for certain stages in the moult cycle due to behavioral changes associated with ecdysis (HARTNOLL, 1982).

Generally, with increasing size the percentage moult increment decreases and the intermoult period lengthens (HARTNOLL, 1982), coincidently, in *P. argentinus* the moulting frequency was found to be dependent of premoult weight, for the range of weight analyzed. The weight growth of this species, according to the growth coefficient (KURATA, 1962) is arithmetic, like that found for *Homarus gammarus* (Linnaeus, 1758) (as *Homarus vulgaris* M.-Edwards) (HEWETT, 1974), *Artemesia longinaris* (PETRIELLA, 1986) and *Pleoticus muelleri* (Bate, 1888) (DÍAZ & PETRIELLA, 1988). A great variability in percentage weight increment has been observed in different taxa of crustaceans, as well as between individuals of the same species. In *P. argentinus* the percentage increment was variable, showing a tendency to decrease with the age. This tendency was also recorded for *Penaeus vannamei* Boone, 1931 (MENZ & BLAKE, 1980), *A. longinaris* (PETRIELLA, 1986) and *P. muelleri* (DÍAZ & PETRIELLA, 1988).

From this study it is possible to recognize the four major stages and five substages of this species through the setogenesis and the relationship between moult and growth can be established.

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